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Study Made to Establish Parameters and Limitations of Explosive Welding

In an analytical study of explosive welding, the analogy of a supersonic stream incident upon a wedge was used to describe the interface configuration of explosive welds. It was theorized that, for welding to occur, metal jetting must be present; the appearance of an explosive weld interface may, therefore, be an indication of the relation of the metal jet velocity and shock wave velocity during the welding process. An examination of specimen welds fabricated under this study indicates that the velocity of the metal jet was slightly less than that of the normal shock wave on the surface of the metal; this is indicated by the metal jet entrapment along the weld interfaces. The velocity differential may be varied by the use of attenuating media between the explosive and the metal surface, or by varying the detonation velocity of the explosive. Because the quality of the welds examined during this study did not indicate any degradation of strength along the weld interfaces, no changes in this velocity relationship was deemed necessary.

The process parameters for effecting explosive patch welds in 1/8-inch thick X-7106-T6 and 1/4-inch thick X-7106-T6351 aluminum alloy were established and demonstrated through testing. Although the sizes of the patches welded under this study were 3 and 4 inches in diameter, the explosive welding parameters reported are, in general, applicable to the explosive welding of patches of various sizes and configurations when using the same alloy, temper, and thickness for which the parameters were established.

Sound explosive scarf welds were fabricated in 0.125-inch thick X-7106-T6 and 0.150-inch thick X-7106-T6351 aluminum alloy material. Difficulties encountered in forming the X-7106 material in the T-6351 reduced the reliability of the welds in the

0.250-inch thickness. In this temper it was impossible to form the tight radii required by the preweld configuration without cracking the material. Data obtained from overlapped and scarf welded explosive welds fabricated and tested under this study indicate that the strength of the material adjacent to the weld has been decreased by work-hardening during forming to the preweld configuration or by shock wave impact during explosive welding.

Sound T explosive welds of 0.250-inch thick X-7106-T6351 aluminum in lengths as great as 36 inches were accomplished using the process parameters established under this study. The quantity of explosive required to accomplish this weld was approximately 44% greater than had been estimated based on previous tests producing sound T welds in 0.250-inch thick 7075-T6 aluminum alloy. This increased explosive charge brought about the failure of the top of the T weld die during a weld test conducted under this study.

The two tests conducted to attach a flange fitting to the experimental structure fabricated under this study were unsuccessful. The reason for the failure to effect this weld cannot be firmly established because of the limited number of tests conducted. It is theorized that the quantity of explosive used, together with its proximity to the center post of the die, resulted in a pressure spike that contributed to the failure of this weld. Sound explosive welds attaching flanged fittings are believed possible if the flange diameter is increased; this would enable the weld to be made with the explosive in contact with the flange surface but not near enough to the boss to cause shock wave damage. Another modification to improve this weld would be to project the boss through the tank wall with the flange contacting the

(continued overleaf)

inside surface of the tank. In this configuration, the explosive would be placed on the bottom surface of the flange and upon detonation, would drive the flange against the tank wall. The explosive welding process would be similar to the explosive patch weld.

Patent status:

Inquiries about obtaining rights for the commercial use of this invention may be made to NASA, Code GP, Washington, D.C. 20546.

Notes:

1. Additional details are contained in: *Establishment of Parameters and Limitations of Explosive Welding*, by F. C. Polhemus, PWA FR-1528, Pratt and Whitney Aircraft, August 27, 1965.
2. Copies of this report are available from:
Technology Utilization Officer
Marshall Space Flight Center
Huntsville, Alabama 35812
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Source: F. C. Polhemus
of Pratt and Whitney Aircraft
under contract to
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